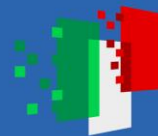




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Spoke 1

**Aerospazio e mobilità sostenibile**

# ELECTRO

Electrically Propelled Vehicles: Charge and Technologies

Scientific leader:

**Paolo Guglielmi**, DENERG, Polito

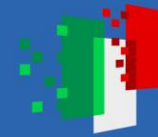
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## Partners



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Tecnologico per l'Ambiente



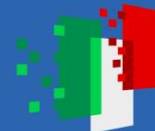
PASSION FOR INNOVATION



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# Twin Transition and Mobility

## Changing paradigms

The automotive sector and the mobility sector are facing multiple challenges, posed by the new technological paradigms that have an impact both on the vehicles and on the related infrastructures. The **key ambition** of the project is to **enhance innovation capabilities of companies** operating along the stages of the value chain of the mobility sector by offering the opportunity to experiment and test new solutions and applications.

The flagship project ELECTRO is devoted to the development of specific actions in the EPV charging environment, from station lab in which different technologies related to the electric vehicle may be assessed and tested to the materials and business models related to EPVs.



# The project

The focus is the development of infrastructure for sustainable mobility based on EPVs Technologies and systems for electric charging for EPVs and related innovative services.

In particular, the flagship project includes and merges different aspects related to the EPV world giving a common proposal that comprehends;

- The **development of charging devices**
- The **study of materials** for next generation mobility
- **Business models development** for EPV market.

## Applied research topics

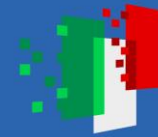
- EPV charging facilities
- High efficiency GaN multilevel active front end for on-board battery chargers
- Testing equipment set-up for electric, autonomous and connected vehicles
- Decision Support System for Local Public Transport Fleet Energy Transition
- Materials for next generation Mobility
- V2X connectivity
- Facility management and logistics based on EPV
- Cooperative vehicle control
- Business model evolution for electric mobility
- Consumption distribution and business model for electric car



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# Results and impact

The project will generate new technical knowledge, with the testing of related solutions and their exploitation by established firms or new ventures; eventually contributing to support the design of innovation paths by the SMEs operating in the ecosystem.

## THE CHARGING LAB

### 10" CONTAINER

IT7900 Grid Simulator

#### Communication Protocols

CCS

NACS

CHAdcMO

Pantograph

#### CANoe PRO

MA-55000

MA-55012

MA-55025

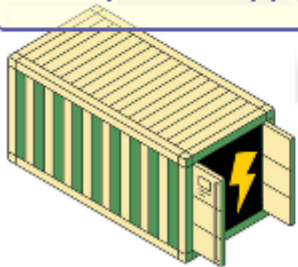
vSECC

MICU300A-S/LF

CCS Listener

OBC +  
battery

ECU



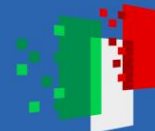
## Main Results Achieved

- 18 Publications
- Integration with INCIT-EV EU project, new consortium on the run
- 2 project in collaboration with firms
- Development of algorithm and software integration tools for Decision Support System for charging plug placing definition in urban environment

Coming next:

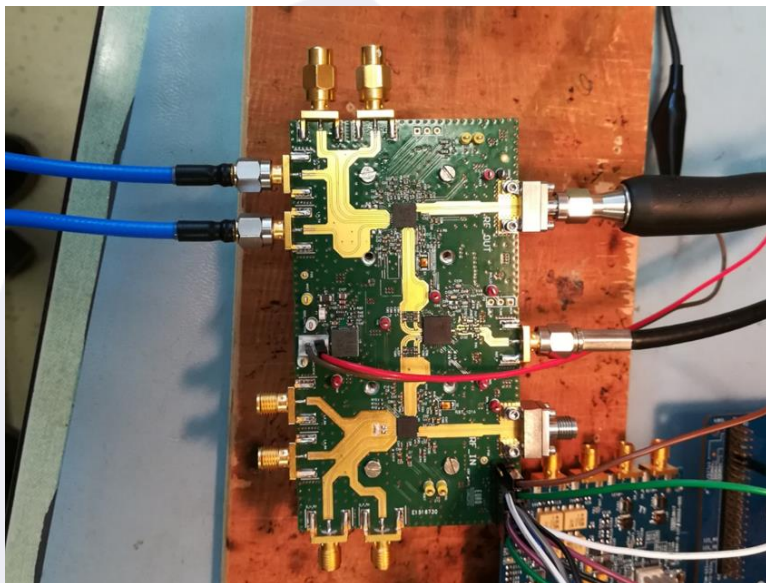
- **The Charging Lab – RM1-RM6**
- **P.Guglielmi**



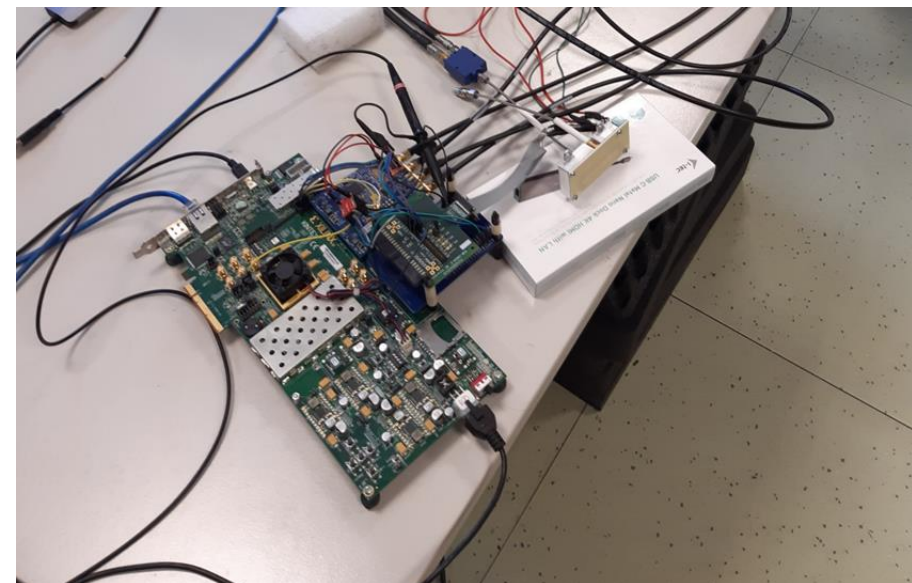


## RM10 - V2X Connectivity – POLITO R. Maggiora

MmWave V2X communication has a lot of potential to enable advanced V2X use cases such as cooperative perception that requires high data rate in the order of Gbps and low latency.



**Developed 28 GHz V2X transceiver prototype board**



**Developed beam management processing system**



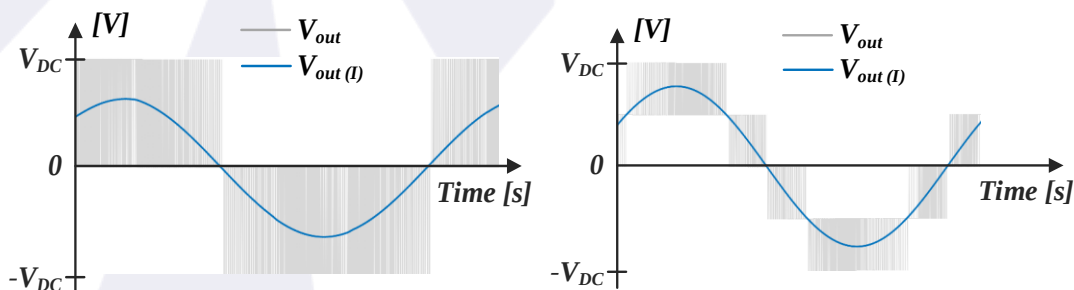
## RM11 - Development of high efficiency GaN multilevel active front ends for on-board battery chargers

UNICT – G. Scelba

### GaN technology in electric vehicle charging equipment:

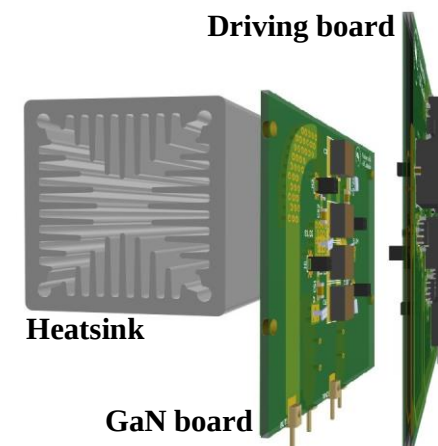
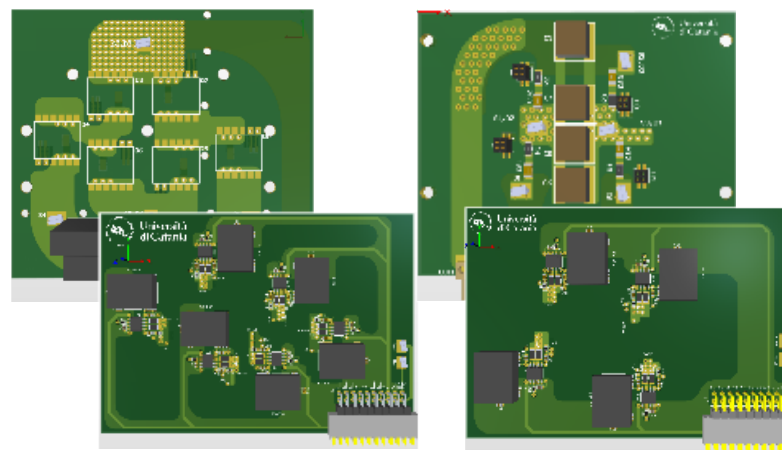
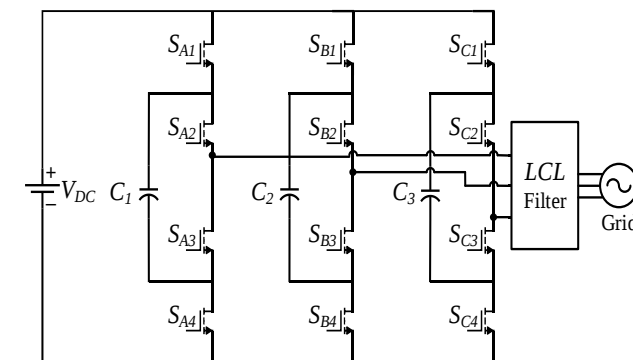
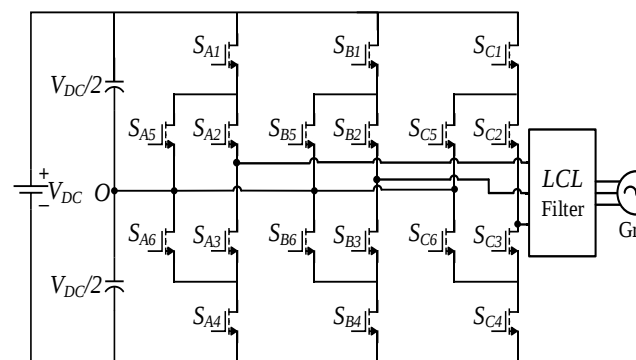
- ✓ Ability for high-temperature operation, reduced reverse recovery, and lower leakage current.
- ✓ Reduced switching losses that permit to substantially increase the switching frequency. This, in turn, results in a reduction in the size and cost of passive components.

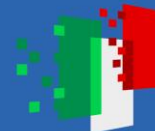
### Multilevel Active Front Ends:



GaN multilevel active front end is an attractive solution for designing very compact and high-efficiency battery chargers.

### Active Front Ends Under Development





## RM10 - Transformation of Value Chain and Work – POLITO P. Neirotti

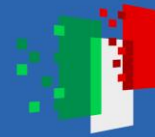
- **Research Group:** Professor Paolo Neirotti, Ph.D. Student Pietro Rombolà
  - **Title:** The Three 'S' Dilemma (i.e., speed, scale, scope)
  - **Type of study:** Longitudinal case study in the energy sector
  - **Status:** Working paper; Already presented at two international conferences should be sent to a journal during this autumn
  - **Preliminary Findings:**
    - I. Documenting MTs resulting from BMI process, an underexplored area compared to BMI categorization;
    - II. Elucidating how these tensions are particularly pertinent to new entrants, who may encounter, speed, scale, and scope-related challenges;
    - III. Thirdly, explaining how CII could assert its influence on the BMI process and how can be a potential solution for the "Three 's' Dilemma".
- **Research Group:** Professor Paolo Neirotti, Assistant Professor Claudia Franzè, Ph.D. Student Pietro Rombolà
  - **Title:** How is value distributed along the value chain of electric vehicle charging infrastructure?
  - **Type of study:** *Multiple* case study in the energy and transportation sector
  - **Status:** Exploration phase
  - **External partnership:** American University of Beirut – Mediterraneo (Cyprus)
  - **Interviews conducted and number of companies involved:** 21 interviews across 19 companies.
  - **Spanning industries already interviewed:** car-manufacturing, power electronics, micro mobility, utility and multi utility, charging point operators, high way management, engineering consulting (in custom batteries and electric engine).



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## RM2 - Decision Support System (DSS) for Local Public Transport (LPT) fleet energy transition – LINKS C. Botta

### Objective

Develop a DSS for the evaluation of LPT energy transition scenarios, both with regard to fleets and recharging infrastructures



### Module #1

Simulation and assessment of **energy transition strategies for TPL fleets**, referring to different scenarios

Results: new types of vehicles to be purchased along the years, impacts on environmental pollutant per year



### Module #2

Assesment of the **possibility of electrify public transport lines** including charging hubs

Results: number of stops to be equipped with charging points, to achieve specific defined goals (e.g., minimization of infrastructure costs, %of recharging in depot, ...).



## RM3 - Materials For Next Generation Mobility – UNITO V. Brunella

Post-industrial and post-consumer recycled  
polypropylene for automotive application



- The properties of **recycled** samples are **similar to** those of **virgin** materials also after different aging tests

### Bio-based epoxy resin

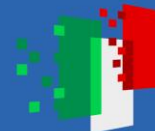
- **New bio-based** epoxy resins with up to **50%** bio-content
- Tensile tests demonstrated **competitive mechanical properties** compared to conventional ones
- Non-isothermal DSC used to develop **model-free and model-based** approaches and to validate the curing process of new formulations



Article

### Cross-Linking Reaction of Bio-Based Epoxy Systems: An Investigation into Cure Kinetics

Pietro Di Matteo <sup>1</sup>, Andrea Iadarola <sup>2</sup>, Raffaele Ciardiello <sup>2</sup>, Davide Salvatore Paolino <sup>2</sup>, Francesco Gazza <sup>3</sup>,  
Vito Guido Lambertini <sup>3</sup> and Valentina Brunella <sup>1,\*</sup>



## RM4 - Facility Management And Logistics – UNITO P. Pisano / F. Damiani

**Objective:** Develop new autonomous, sustainable and resilient models for facility management, comprising AMR and ML technologies that are able to be run without connectivity.

- **Research Group:** 3 papers: G.Audrito, R. Casadei, F. Damiani, G. Salvaneschi, M. Viroli, P. Pisano, M. Pescarollo, M. Manzo
- **Titles:** 1) A general framework and decentralised algorithms for collective computational processes 2) The eXchange Calculus (XC): A functional programming language design for distributed collective systems 3) The contribution of Italian Innovation Ecosystems to promoting Knowledge Transfer and Technology Transfer in Entrepreneurial Education: a Case Study
- **Status:** two papers published and presented at two international conferences; one working paper presented at international conference, paper to be published.
- **Preliminary Findings:**
  - I. Distributed collective systems, like wireless sensor networks and robot swarms, involve devices collaborating in shared environments but are difficult to program due to scalability, concurrency, and fault tolerance. The eXchange Calculus implemented with different platform trade-offs demonstrated in a smart city scenario.
- **PoC in Industrial environment:** P. Pisano, G. Audrito, F. Damiani, F. Cena, L. Paolini, G. Torta, M. Pescarollo
- **Title:** RoboApp - Robotic Aggregate Programming Platform
- **Objective:** The project aims to develop an innovative IoT platform for deploying and managing autonomous secure and resilient AMRs technologies in facility management, with planned experimentation at Turin Airport.
- **Milestone:**
  - I. Facility Management Analysis
  - II. Prototyping for Industrial environment
  - III. Optimization through AI and ML
  - IV. PoC Demonstration at Turin Airport
  - V. Impact Evaluation



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**Grazie per l'attenzione**

This presentation is part of the project NODES which has received funding from the MUR – M4C2 1.5 of PNRR funded by the European Union - NextGenerationEU (Grant agreement no. ECS00000036)